IS 11334 (1984): Method of Measurement for Piezoelectric Ceramic Resonators and Resonator Units for Frequency Control and Selection [LITD 5: Semiconductor and Other Electronic Components and Devices]

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Indian Standard

METHOD OF MEASUREMENT FOR PIEZOELECTRIC CERAMIC RESONATORS AND RESONATOR UNITS FOR FREQUENCY CONTROL AND SELECTION

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

METHOD OF MEASUREMENT FOR PIEZOELECTRIC CERAMIC RESONATORS AND RESONATOR UNITS FOR FREQUENCY CONTROL AND SELECTION

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Indian Standard

METHOD OF MEASUREMENT FOR PIEZOELECTRIC CERAMIC RESONATORS AND RESONATOR UNITS FOR FREQUENCY CONTROL AND SELECTION

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 September 1984, after the draft finalized by the Piezoelectric Devices for Frequency Control and Selection Sectional Committee had been approved by the Electronic and Telecommunication Division Council.

0.2 The object of this standard is to establish uniform conditions for assessing the mechanical, electrical and climatic properties of piezoelectric ceramic resonators, to describe test methods, to give recommendations for standard values and to give guidance for the use of such resonators.

0.3 This standard gives general information and general methods of measurement and test common to many types of ceramic resonators.

0.3.1 The applicability of the tests to each type of ceramic resonator and the specific requirements for each test shall be given in the individual relevant specification.

0.3.2 In case of conflict between the requirement of this specification and the individual relevant specification, the latter shall take precedence.

0.4 In preparing this standard, assistance has been derived from IEC Pub 642—first edition (1979) Piezoelectric ceramic resonators and resonator units for frequency control and selection, Chapter 1 : Standard values and conditions, Chapter II : Measuring and test conditions.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard relates methods of measurement for piezoelectric ceramic resonators and resonator units for use in frequency selection circuits.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part 44)-1978* shall apply.

3. STANDARD VALUES AND TOLERANCES

3.1 Standard Levels of Drive — The standard levels of drive in the neighbourhood of resonance are:

0·01 mW; 0·02 mW; 0·05 mW; 0·1 mW; 0·2 mW;
0·5 mW; 1·0 mW; 2·0 mW; 5·0 mW; and 10·0 mW.

3.1.1 All ±10 percent unless otherwise specified in the relevant specification.

3.2 Standard Operating Temperature Ranges — The standard operating temperature ranges are:

−55 to +105°C
−40 to +85°C
−20 to +70°C
−10 to +60°C
0 to +60°C
+10 to +40°C

3.2.1 Other temperature ranges may be used, but the lowest temperature shall not be less than −60°C and the highest temperature shall not exceed 105°C.

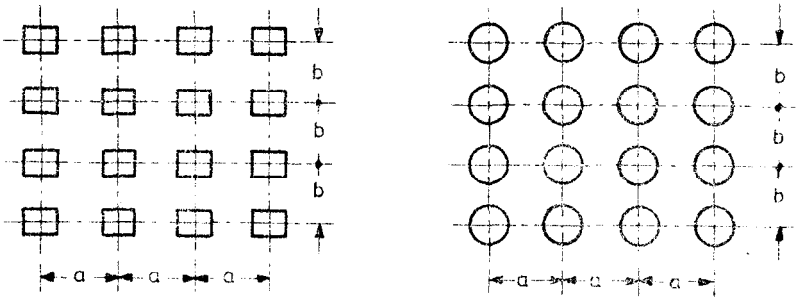
3.3 Standard Enclosure Terminal Spacing — Standard enclosure terminal spacings of a piezoelectric ceramic resonator unit are as follows (*see* Fig.1).

4. MARKING

4.1 Each piezoelectric ceramic resonator unit shall have the following information indelibly and legibly marked upon it:

a) Nominal frequency expressed in kilohertz or in megahertz;
b) Mark of origin (manufatcurer's name, which may be in code form, or trade-mark); and
c) Any other information necessary to obtain a complete definition of the unit.

*Electrotechnical Vocabulary: Part 44 Piezoelectric devices.



Flat Terminals Wire-lead Terminals

Dimensions:

a = (1/4), 1/2, (3/4), 1/1 of 2·54 mm; and

b = (1/4), 1/2, (3/4), 1/1 of 2·54 mm

FIG. 1 STANDARD ENCLOSURE TERMINAL SPACING

4.2 The piezoelectric ceramic resonator unit may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

5. GENERAL CONDITIONS FOR TESTS

5.1 The electrical measuring methods allow the electrical characteristics of the piezoelectric ceramic resonator and resonator unit to be judged in the 'as received' condition. The ability of the resonator unit to maintain these charcteristics during and after a certain period of use may be assessed by subjecting a number of samples to the mechanical and climatic tests of IS : 9000 (Part 1)-1977* and sealing and storage tests given hereafter.

5.2 After these tests, the specimens shall be able to meet the requirements for electrical characteristics and, if specified, also during one or more of these tests. The schedule for type tests showing all possible tests and the order of their application is given in Appendix A. It may be used as a

*Basic environmental testing procedures for electronic and electrical items: Part 1 General.

check list to draw up the type test schedule for a particular case. When doing so, the following points have to be considered:

a) electrical requirements;

b) tests to be made and their order of application (test schedule);

c) severities of the test;

d) extent of the measurements to be made after the tests in order to verify whether the specimens have successfully passed the tests; and

e) number of specimens to be tested, their division over the separate lots and the permissible number of rejects.

5.3 Resonator (units) which have been subjected to these type tests should not used in equipment or returned to bulk supply.

6. STANDARD CONDITIONS FOR TESTS

6.1 Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for tests as specified in 3.3 of IS : 9000 (Part 1)-1977*.

For example:

Temperature	15 to 35°C,
Relative humidity	45 to 75 percent, and
Air pressure	86 to 106 kPa.

6.2 Before the measurements are made, the resonators (units) shall be stored at the measuring temperature for a time sufficient to allow the resonators (units) to reach this temperature.

6.3 When measurements are made at a temperature other than the standard temperature, the results shall, where necessary, be corrected to the specified temperature. The ambient temperature during the measurements shall be stated in the test report.

NOTE — During measurement, the resonators (units) shall not be exposed to conditions likely to invalidate the results of the measurements.

*Basic environmental testing procedures for electronic and electrical items: Part 1 General.

7. VISUAL EXAMINATION

7.1 External Visual Examination

7.1.1 The dimensions shall be checked and they shall comply with the specified values.

7.1.2 The marking shall be legible and durable.

8. ELECTRICAL TESTS

8.1 Measurement of Vibrator Constants

8.1.1 The vibrator constants, that is resonance frequency, relative frequency spacing, resonance resistance or mechanical quality factor and free capacitance measured in accordance with **8.1.2** shall be within the specified limits.

8.1.2 The vibrator constants shall be determined under specified conditions, the waveform being substantially sinusoidal, using the standard method described in **8.1.3**.

Alternatively, the resonance frequency and resonance resistance may be measured with any suitable method provided the results correlate with the results obtained using the standard method to a degree consistent with the accuracy required.

8.1.3 Standard methods of measurement are given in IS : 7962-1975*, IS : 7957-1976† and IS : 11014 (Part 1)- 1984‡.

8.2 Resonance Frequency, Relative Frequency, Spacing and Resonance Resistance as a Function of Drive Level

8.2.1 The measurements of **8.1** shall be repeated at the specified drive levels. The change of resonance frequency, relative frequency, spacing and resonance resistance shall be within the specified limits.

NOTE 1 — Measurement levels may be represented by relative values (in decibels) to a standard level of drive. Step values and tolerance will be as follows: 20, 10, 6, 3, 0·3, −6, −10, −20, −30, −40, −60 and −80; tolerance ± 1 dB.

NOTE 2 — Before measuring drive at high level, the following conditions shall be specified and recorded.

a) Duration,

b) Ambient conditions, and

c) Other necessary items.

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*Methods of measurement for piezoelectric vibrators operating over the frequency range up to 30 MHz.

†Basic method for the measurement of resonance frequency and equivalent series resistance of quartz crystal units by zero technique in a π-network.

‡Specification for piezoelectric ceramic material: Part 1 General aspects and methods of measurements.

8.3 Vibrator Constants as a Function of Temperature

8.3.1 The vibrator constants shall be measured over the specified temperature range and times under specified conditions of thermal equilibrium and in accordance with **8.1**. Throughout the specified temperature range, the vibrator constants shall not exceed the specified requirements.

8.3.2 Sequence for these test temperature shall be as follows (*see* Fig. 2):

a) Standard temperature,

b) Lowest operating temperature,

c) Standard temperature,

d) Highest operating temperature, and

e) Standard temperature.

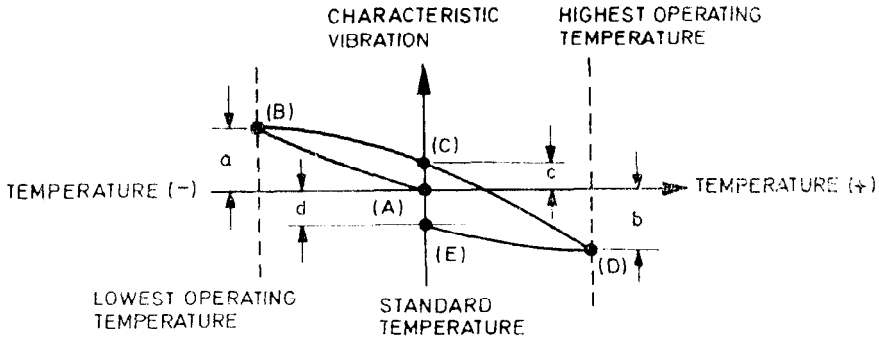

FIG. 2 SEQUENCE OF TEST TEMPERATURE

8.3.2.1 Before the test the resonator (unit) under test shall be left at the test temperature for any of the durations specified below for at least : 0·5 h, 1 h and 2 h.

8.4 Unwanted Response

8.4.1 Using the method of measurement of **8.1** of the frequency is scanned over the specified range and the frequency and resonance resistance of all the responses within this range shall be measured.

8.4.2 The resonance resistance of all the unwanted responses shall be greater than the specified limit.

8.5 Insulation Resistance

8.5.1 The insulation resistance shall be measured as follows:

a) Select dc test voltage from the following (dependent upon the thickness and the polarization characteristics of the resonator): 10 V, 25 V, 50 V, 100 V, 250 V and 1 000 V; and

b) Voltage tolerance: +10 percent.

8.5.2 Apply a test voltage from **8.5.1** between the following two points, for at least 20 s and not more than 2 min.

a) Enclosure terminals;

b) Enclosure and terminal (when enclosure is metal); and

c) Resonator electrodes, or lead-wires.

NOTE — The specified insulation resistance may be one of the following: 1 MΩ, 1 C MΩ, 100 MΩ, or 1 000 MΩ.

8.6 Permissible dc Voltage

8.6.1 Measure the vibrator constants before and after applying the following voltage across terminals. Obtain deviation in constants.

a) Apply a positive voltage for 30 ± 5 s. Then apply a negative voltage for the same duration. Leave the resonator at zero voltage for at least 30 min. Measure the resonator constants as in **8.1**.

b) The permissible dc voltage shall be one of the following (dependent upon the thickness and the polarization characteristics of the resonator); ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, ±500 V, ±1 000 V and ±2 000 V.

8.6.2 Tolerance: ±10 percent.

8.7 Permissible ac Voltage

8.7.1 Measure the vibrator constants before and after applying the following voltages across terminals. Obtain deviation in constants.

a) Apply permissible ac voltage (50 Hz or 60 Hz) across terminals for 1 min ±10 s. Then leave the resonator at zero voltage for at least 30 min.

b) The permissible ac voltage shall be one of the following (dependent upon the thickness and the polarization characteristics of the resonator) : 5 V, 10 V, 20 V, 50 V, 100 V, 200 V, 500 V, and 1 000 V in rms value.

8.7.2 Tolerance: ±10 percent.

8.8 Permissible Input Level

8.8.1 Measure the vibrator constants before and after applying the following voltages across terminals. Obtain deviation in constants:

a) Apply permissible input level at nominal frequency across a resonator for at least 10 min and not more than 1 h. Then leave the resonator at zero voltage for at least 1 h.

b) The permissible input levels shall be represented in volts, amperes (milliamperes) or watts (milliwatts).

9. MECHANICAL AND CLIMATIC TESTS

9.1 Bumping

9.1.1 The resonator units shall be subjected to the procedure of Sec 2 of IS : 9000 (Part 7)-1979* using the specified degree of severity, the enclosure of the resonator unit being clamped.

9.1.2 The resonator units shall then be visually examined. There shall be no visible damage.

9.1.3 The resonance frequency and resonance resistance shall then be measured. The change of resonance frequency and resonance resistance compared with the values measured in **8.1.2** shall not exceed the specified limits.

9.1.4 If this test is included in the relevant specification, the following shall be specified:

a) Degree of severity of the test,

b) Axes along which the force shall be applied, and

c) Limits of change of resonance frequency and resonance resistance.

9.2 Shock

9.2.1 The resonator units shall be subjected to the procedure of Sec 1 of IS : 9000 (Part 7)-1979*, using the specified degree of severity, the enclosure of the resonator unit being clamped.

9.2.2 The resonator unit shall then be visually examined. There shall be no visible damage.

9.2.3 The resonance frequency and resonance resistance shall then be measured. The change of resonance frequency and resonance resistance compared with the values measured in **8.1.2** shall not exceed the specified limits.

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*Basic environmental testing procedures for electronic and electrical items: Part 7 Impact.

9.2.4 If this test is included in the relevant specification the following shall be specified:

a) Degree of severity of the test,
b) Axes along which the force shall be applied, and
c) Limits of change of resonance frequency and resonance resistance.

9.3 Vibration

9.3.1 The resonator units shall be subjected to the procedure of IS : 9000 (Part 8)-1981* using the specified degree of severity.

9.3.2 Unless otherwise specified, the resonator units are rigidly clamped to the vibration table. Wire terminals, if any, shall be clamped at approximately 10 mm from the enclosure so that they are maintained in their original position.

9.3.3 After the vibration conditioning, the resonator units shall be visually examined. There shall be no visible damage.

9.3.4 The resonance frequency and resonance resistance shall then be measured. The change of resonance frequency and resonance resistance compared with the values measured in **8.1.2** shall not exceed the specified limits.

9.3.5 If this test is included in the relevant specification, the following shall be specified:

a) Detailed sequence of the test procedure,
b) Degree of severity of the test,
c) Axes of vibration, and
d) Limits of change of resonance frequency and resonance resistance.

9.4 Acceleration, Steady State

9.4.1 The resonator units shall be subjected to the procedure of IS : 9000 (Part 9)-1981†, the body of the enclosure being clamped.

9.4.2 The resonance frequency and resonance resistance shall then be measured. The change of resonance frequency and resonance resistance compared with the values obtained from the preceding measurements shall not exceed the specified limits.

9.4.3 If this test is included in the relevant specification, the following shall be specified:

a) Degree of severity of the test,
b) Axes and direction of acceleration, and
c) Limits of change of resonance frequency and resonance resistance.

*Basic environmental testing procedures for electronic and electrical items: Part 8 Vibration.

†Basic environmental testing procedures for electrical items: Part 9 Acceleration steady state.

9.5 Tensile Strength of Terminations

9.5.1 The resonator unit shall be subjected to the procedure of IS : 9000 (Part 19)-1978* using the specified severity.

9.5.2 After the test there shall be no visible damage to the resonator unit.

9.5.3 If this test is included in the relevant specification, the force shall be specified.

9.6 Flexibility of Wire Terminations

9.6.1 The resonator unit shall be subjected to the procedure of IS : 9000 (Part 19)-1978* using the specified severity.

9.6.2 After the test there shall be no visible damage to the resonator unit.

9.6.3 If this test is included in the relevant specification, the following shall be subjected:

a) Force,

b) Number of bends, and

c) Location of the bend relative to the enclosure base.

9.7 Bend Test on Pin Terminations (Applicable to Undercut Pins Only)

9.7.1 The enclosure or base of the resonator unit shall be held or clamped by any convenient means. A bending tool suitable for the specific enclosure shall be used to engage that segment of the pin terminals beyond the undercut portion.

To ensure that the bending will occur primarily at the undercut portion, a plate with two clearance holes for the pins may be placed over the pins. This plate may be of such thickness as to include a portion of the undercut section of the pins.

The pins shall be bent by means of the tool through $15 \pm 2°C$ in one direction followed by a bend of $30 \pm 2°$ in the opposite direction and completed by a bend of $15 \pm 2°$ back to its starting position.

The rate of bending shall be approximately 3 second per bend in each direction.

9.7.2 After the test there shall be no visible damage to the resonator unit.

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*Basic environmental testing procedures for electronic and electrical items: Part 19 Robustness of terminations.

9.8 Sealing (Hermetically Sealed Type)

9.8.1 The resonator unit shall be subjected to the procedure of IS : 9000 (Part 15)-1982*.

9.8.2 The resonator unit is immersed in degassed liquid for a specified period of time.

9.8.3 There shall be no leakage, as determined by repetitive bubles emerging from the resonator unit.

9.8.4 After the test there shall be no visible damage to the resonator unit.

9.8.5 If this test is included in the relevant specification, the following shall be specified:

a) Degassed liquid temperature, and

b) Test duration.

NOTE — This test is for qualitative purposes only.

9.9 Solderability

9.9.1 The resonator unit shall be subjected to the procedure of Sec 1 of IS : 9000 (Part 18)-1981† (Solder bath method, 230 ± 10°C).

9.10 Electrode Film Bond Strength for Thick Electrode — Test the bond strength of electrode film is given in subsequent clauses.

9.10.1 The bonding strength shall be represented in pascals = N/M^2 from the following:

1 MPa, 2 MPa, 5 MPa, 7 MPa or 10 MPa.

9.10.2 Prepare a standard specimen set in the standard test conditions. Comply a tensile load (any of the values given above) to the electrode film.

9.10.2.1 Increase the load continuously at a speed of not more than 50 mm/min to elimate martia effects.

9.10.3 Prepare the standard sample as follows:

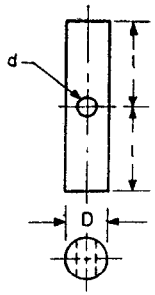
a) Cut a square plate measuring 5 mm × 5 mm, or a disc with an equivalent area, from a resonator (units). Solder a metal fitting and attachment for a standard tensile test as shown in Fig. 3;

b) Specify solder to be used and soldering conditions before test sampling as in (a) above; and

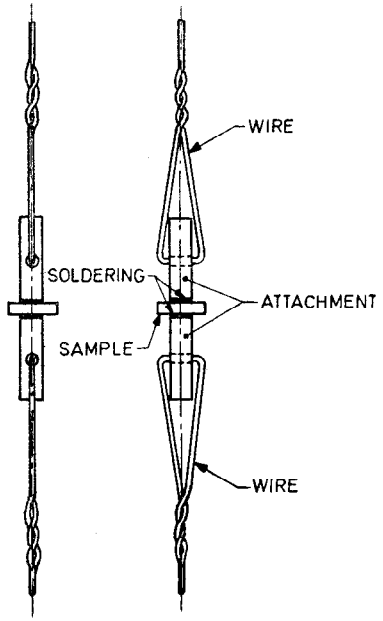
c) The tensile load shall be specified.

*Basic environmental testing procedures for electronic and electrical items: Part 15 Sealing Test.

†Basic environmental testing procedures for electronic and electrical items: Part 18 Solderability Test.



3A ATTACHMENT



3B TEST PIECE

SYMBOL	DIMENSIONS
l	5·0 mm
D	2·5 mm
d	1·0 mm

FIG. 3 ATTACHMENT AND TEST PIECE

9.11 Lead-Wire Adhesion Strength — Test the adhesion strength of lead-wires to the resonator is given in subsequent clauses.

9.11.1 The tensile load to lead-wire shall be selected from the following unless otherwise specified:

0·1 N, 0·2 N, 0·5 N, 1·0 N, 2·0 N, 5·0 N, or 10 N.

9.11.2 With the resonator body secured to the test bench, apply any tensile lead from those given in **9.10.1** perpendicularly to the electrode surface, or in the axial direction of lead wires in normal situation. Hold the load for 30 ± 5 s, and remove it promptly.

9.11.3 If this test is included in the relevant specification, the tensile load shall be specified.

9.12 Resonator Transverse Strength — Test the transverse strength of resonators is given in subsequent clauses.

9.12.1 Support a prepared test specimen at two points close to its ends as shown in Fig. 5. Gradually increase the load at the centre of the sample in the direction perpendicular to it.

9.12.2 Increase the load until the specimen breaks and read the breakdown weight in newtons.

9.12.3 Calculate the transverse strength of the resonator using the following equation:

$$T = \frac{3}{2} \frac{F l_s}{b t^2} \text{ (MPa)}$$

where

F = maximum load in newtons,

l_s = centre to centre distance of supporting rods in millimetres,

b = specimen width in millimetres, and

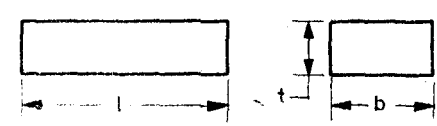
t = specimen thickness in millimetres.

9.12.4 Specimen shape and dimensions are shown in Fig. 4, and supporting method in Fig. 5.

9.12.5 If this test is included in the relevant specification, the transverse strength shall be specified.

9.13 Thermal Shock

9.13.1 The vibrator constants shall be measured.



L	*b*	*t*	*R*
40 mm	20 mm	10 mm	3 mm

FIG. 4 DIMENSIONS OF SPECIMEN

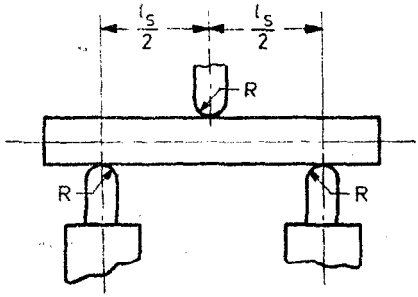


FIG. 5 SUPPORTING METHOD

9.13.2 The resonator (unit) shall be subjected to the procedure of IS : 9000 (Part 14)-1978*.

9.13.3 The vibrator constants shall be measured. The change of vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits.

9.13.4 After the test there shall be no visible damage to the resonator unit.

9.13.5 If this test is included in the relevant specification, the following shall be specified:

a) The low temperature,

b) The high temperature,

c) Rate of change,

d) Number of cycles, and

e) Duration.

9.14 Dry Heat

9.14.1 The vibrator constants shall be measured.

9.14.2 The resonator unit shall be subjected to the procedure of IS : 9000 (Part 3/Sec 1 to 5)-1977† at the specified temperature.

9.14.3 The vibrator constants shall then be measured. The change of the vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits.

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*Basic environmental testing procedures for electronic and electrical items: Part 14 Change of temperature.

†Basic environmental testing procedures for electronic and electrical items: Part 3 Dry heat, Sections 1 to 5

9.14.4 If this test is included in the relevant specification, the limits of change of the vibrator constants and the temperature shall be specified.

9.15 Damp Heat, First Cycle

9.15.1 The vibrator constants shall be measured.

9.15.2 The resonator unit shall be subjected to the procedure of IS : 9000 (Part 5)-1981* for one cycle.

9.15.3 The vibrator constants and the insulation resistance shall then be measured. The change of vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits. The insulation resistance shall be not less than the specified value.

9.15.4 After these measurements the units shall be subjected immediately to the cold test.

9.15.5 If this damp heat test is included in the relevant specification, the following shall be specified:

a) The limits of change of vibrator constants, and

b) The minimum value of the insulation resistance.

9.16 Cold

9.16.1 The vibrator constants shall be measured.

9.16.2 The resonators (units) shall be subjected to the procedure of IS : 9000 (Part 2/Sec 1 to 4)-1977†.

9.16.3 The vibrator constants shall then be measured. The change of vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits.

9.16.4 If this test is included in the relevant specification, the limits of change of vibrator constants shall be specified.

9.17 Damp Heat, Remaining Cycles

9.17.1 The vibrator constants shall be measured.

9.17.2 The resonator (unit) shall be subjected to the procedure of IS : 9000 (Part 5)-1981* for the remaining five cycles.

*Basic environmental testing procedures for electronic and electrical items: Part 14 Change of temperature: heat. Part 5 Damp heat.

†Basic environmental testing procedures for electronic and electrical items: Part 2 Cold, Section 1 to 4.

9.17.3 The vibrator constants shall then be measured. The change of vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits. The insulation resistance shall be not less than the specified value.

9.17.4 If this test is included in the relevant specification, the following shall be specified:

a) The limits of change of vibrator constants, and

b) The minimum value of the insulation resistance.

9.18 Damp Heat (Long-Term Exposure)

9.18.1 The vibrator constants shall be measured.

9.18.2 The resonator (units) shall be subjected to the procedure of IS : 9000 (Part 4)-1979*.

9.18.3 The vibrator constants and insulation resistance shall then be measured. The change of vibrator constants compared with the values obtained from the preceding measurements shall not exceed the specified limits. The insulation resistance shall be not less than the specified value.

9.18.4 If this test is included in the relevant specification, the following shall be specified:

a) The limits of change of vibrator constants, and

b) The minimum value of the insulation resistance.

9.19 Ageing

9.19.1 The resonators (units) shall be subjected to the specified temperature for the specified period.

9.19.2 As soon as the resonator (unit) has reached thermal stability at the test temperature, the vibrator constants shall be measured and recorded.

9.19.3 At specified internals, during the period called for in **9.19.1** and at the end of that period, the change of vibrator constants compared with the values measured in **9.19.2** shall be determined.

During these measurements, the resonator (unit) shall still be at the test temperature. The maximum deviation of that temperature from the temperature recorded in **9.19.2** shall be consistent with the accuracy of the measuring result to be obtained.

*Basic environmental testing procedures for electronic and electrical items: Part 4 Damp heat (steady state).

9.19.4 If this test is included in the relevant specification, the following shall be specified:

a) The duration of the test and the temperature of ageing and measurement,

b) The measurement intervals, and

c) The limits of change of vibrator constants.

APPENDIX A

(*Clause* 5.2)

GENERAL RECOMMENDATIONS FOR TYPE TESTS

A-1. DEFINITONS

A-1.1 Type — A type comprises piezoelectric ceramic resonators and resonator units of one design made by one manufacturer. Mounting accessories are ignored, provided they have no significant effect on the test result.

NOTE — The design of a resonator (unit) includes the combination of:

a) electrical characteristics,

b) environmental characteristics,

c) construction, and

d) outline.

A-1.2 Type Test — The type test of a resonator is the complete series of tests to be carried out on a number of specimens representative of the type, with the object of determining whether a particular manufacturer may be considered able to produce resonators (units) meeting the specification.

A-1.3 Type Approval — Type approval is the decision by the proper authority (the user himself or his nominee) that a particular manufacturer may be considered able to produce in reasonable quantities the type meeting the specification.

A-2. SCHEDULE OF TYPE TESTS

A-2.1 The appropriate number of specimens to be tested and the number of permissible failures shall be agreed upon between user and manufacturer.

NOTE — The results of some tests are independent of certain type characteristics, for example, the result of the temperature cycle test generally depends on the case design only. In this case, the test need not be carried out on specimens from each individual type.

A-2.2 All specimens shall be subjected to the following tests in the order stated below:

A-2.2.1 *Piezoelectric Ceramic Resonator Units* — The following tests shall be carried out on each resonator unit:

Test	*Clause Reference*
External visual examination	7.1
Sealing test (hermetically sealed type only)	9.8
Vibrator constants at standard atmospheric conditions	8.1
Resonance frequency and resonance resistance as a function of drive level	8.2
Vibrator constants as a function of temperature	8.3
Unwanted response	8.4
Insulation resistance	8.5

A-2.2.2 *Piezoelectric Ceramic Resonators* — The following tests shall be carried out on each resonator:

Test	*Clause Reference*
External visual examination	7.1
Vibration constants at standard atmospheric condition	8.1
Resonance frequency and resonance resistance as a function of drive level	8.2
Vibrator constants as a function of temperature	8.3
Unwanted response	8.4
Insulation resistance	8.5

A-2.3 The resonators (units) shall then be divided into three equal lots. All resonator (units) in each lot shall undergo the following tests in the order stated hereafter.

A-2.3.1 Piezoelectric Ceramic Resonator Units — The following tests shall be carried out lot wise on the resonator units:

Test	*Clause Reference*
First lot:	
Bumping	9.1
Shock	9.2
Vibration	9.3
Acceleration, steady state	9.4

Test	*Clause Reference*
Solderability	9.9
Thermal shock	9.13
Dry heat	9.14
Damp heat, first cycle	9.15
Cold	9.16
Damp heat, remaining cycles	9.17
Mechanical test on terminations	9.5, 9.6, 9.7
Vibrator constants at standard atmospheric conditions	8.1
Second lot:	
Damp heat, long-term exposure	9.18
Permissible dc voltage	8.6
Permissible ac voltage	8.7
Permissible input level	8.8
Vibrator constants at standard atmospheric conditions	8.1
Third lot:	
Ageing	10.19
Vibrator constants at standard atmospheric conditions	8.1

A-2.3.2 *Piezoelectric Ceramic Resonators* — The following tests shall be carried out lot wise on the resonators:

Test	*Clause Reference*
First lot:	
Thermal shock	9.13
Dry heat	9.14
Vibrator constants at standard atmospheric conditions	8.1
Electrode film bond strength	9.10
Lead-wire adhesion strength	9.11
Second lot:	
Permissible dc voltage	8.6

Test	*Clause Reference*
Permissible ac voltage	8.7
Permissible input level	8.8
Vibrator constants at standard atmospheric conditions	8.1
Resonator transverse strength	9.12
Third lot:	
Ageing	9.19
Vibrator constants at standard atmospheric conditions	8.1